Reducing the Cost of Compliance and Improving Plant Operations for Coal-Fired Boilers

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ABSTRACT
Compliance with new environmental regulations for coal-fired boilers and other industrial sources has become a multi-pollutant effort in which minimizing costs is important. For example, the cost of mercury control chemicals is the largest cost associated with achieving mercury compliance under Mercury and Air Toxics Standards (MATS). Reducing the costs associated with maintaining emissions limits requires a deep understanding of process chemistry and equipment operation. ADA-ES, Inc. conducted its first mercury control test on a coal-fired power plant in 1990 and has since conducted over 100 demonstrations at plants throughout North America. The company has also provided activated carbon injection systems for 140 boilers, and collaborated on the development and testing of the industry-leading mercury CEMS systems. ADA is now offering the industry a review of system operation with the objective of reducing the costs and increasing the reliability of MATS compliance. During this paper, an overview of the challenges associated with achieving reliable compliance with MATS and other new regulations will be provided, along with ADA’s approach to supporting reliable compliance by reviewing, monitoring, and supporting operations from coal-pile to stack.

INTRODUCTION
For nearly two decades, ADA has conducted more than 100 mercury control demonstrations at coal-fired power plants and sold activated carbon injection systems maintaining mercury control for more than 140 boilers. Our portfolio of products has grown to address limitations in coal composition, balance-of-plant impacts from alternate approaches, and operational challenges introduced by other technologies. We were the first to understand these environmental issues and provide a range of commercial solutions to the industry.

ADA delivers an important combination of hands-on experience, industry expertise, demonstrated commercial products, and commitment to collaborating with customers. Our track record includes securing more than 35 US patents, with additional US and international patents pending, and receiving numerous prestigious industry awards for emissions control technology and systems. No matter the challenges our customers face, ADA will continue to focus its significant expertise and resources to innovating for a cleaner energy future.
Legislation and Environmental Regulations

Air emissions from coal-fired boilers and industrial sources are regulated under the federal Clean Air Act as well as under state rules. These are multi-pollutant rules, which can increase the complexity of finding a compliance solution. The control of particulate matter (PM) must be accomplished while controlling both acid gases and mercury. As summarized below, specific federal rules apply to each source category.

Federal Mercury and Air Toxic Standards (MATS)
On December 16, 2011, the U.S. Environmental Protection Agency (EPA) issued the final MATS rule, which took effect on April 16, 2012. Affected units had to be in compliance on April 16, 2015, unless they received a one-year extension of the compliance date to April 16, 2016. The MATS rule is based on the maximum achievable control technology (MACT) framework for hazardous air pollutant (HAP) regulations. The rule is applicable to coal and oil-fired Electric Utility Steam Generating Units (EGUs) that generate electricity via steam turbines and provides for, among other provisions, control of mercury and particulate matter, and control of acid gases and other HAPs.

State Mercury and Air Toxics Regulations Affecting EGUs
In addition to federal MATS rules, certain states have their own mercury rules that are similar to, or more stringent than MATS. Power plants around the country are also subject to consent decrees that require the control of acid gases and particulate matter, in addition to mercury emissions. Seventeen states have mercury-specific rules that affect more than 260 generating units.

Industrial Boiler MACT
In January, 2013, the EPA issued the final rule limiting emissions of mercury, hydrogen chloride (HCl), particulate matter (PM) and other pollutants from industrial boilers through the National Emission Standards for Hazardous Air Pollutants, also known as the IB MACT. Starting January 31, 2016, industrial boilers must begin compliance with the Industrial Boiler (IB) MACT which limits emissions of mercury, acid gases, particulate matter, and carbon monoxide. Some boiler owners may be granted a one-year extension delaying the compliance date until January 31, 2017. Within 180 days of the compliance date, industrial boiler operators must demonstrate compliance. The EPA estimates that approximately 600 coal-fired boilers will be affected by the IB MACT in industries such as pulp and paper.

Cement MACT
In addition to issuing standards covering electric power generators, the EPA has developed a MACT-based mercury emissions regulation for the Portland cement industry through amendments to the National Emission Standards for HAPs (the Cement MACT). The EPA published the final Cement MACT regulation on February 12, 2013 with compliance required by September 9, 2015.
COMPLIANCE CHALLENGES & SOLUTIONS

There are unique challenges associated with achieving reliable emissions compliance. The cost of mercury control chemicals is the largest cost associated with achieving mercury compliance under MATS. Reducing the costs associated with maintaining emissions limits requires a deep understanding of process chemistry and equipment operation as well as good Hg measurements. For example, results from tests conducted in the spring may not represent performance during hot summer months.

ADA’s Health Check provides a strategy review combined with expert analysis to ensure consistent and optimal compliance. This is a value-added approach from our experts, who have unmatched mercury control experience. ADA® Health Check will help a plant answer critical questions, including:

- Are my systems ready for MATS?
- Can I reduce my compliance costs?
- Does my plant have any unique operating concerns that impact compliance, e.g.,
  - Coal variability?
  - Plant cycling?
  - Seasonal operational changes?
- Will my scrubber reliably control mercury?
- Is my ESP or Fabric Filter up to the task?
- Could MATS restrict my fuel and year-round operational flexibility?
- Is my monitoring strategy saving me time and money?
- Am I using the right/best sorbent?
- Will halogen improve performance?
- Am I spending my compliance dollars wisely?
- Can I mitigate my risks with ACI trim capabilities?
- Will my strategy impact other current or pending environmental rules?

Mercury in coal-fired plants exhibits complex chemistry. There are multiple factors that affect mercury emissions control. For example, the amount and form of mercury present downstream of an air preheater at a power plant is affected by: coal and ash composition, boiler type, coal classifier operation, combustion performance, SCR design and operation, air
preheater design and operation. Understanding how one boiler and associated APCD are operating compared to others in the industry is very challenging.

ADA’s in-house team of experts uses an interactive engineering process to review plant operations from coal pile to stack to assess the “health” of your control systems. We will evaluate options to improve performance and reduce costs as well as provide you a detailed analysis for planning purposes.

We begin with brief interviews with the operators along with a detailed review of historical data. This not only helps us identify key trends in your control effectiveness, but also uncovers potential threats to your compliance strategy. Next, we travel to the plant to meet with operators and inspect the equipment (baghouse, ESP, ACI, DSI, coal additive injection, mercury CEMS, etc.) to determine if any equipment upgrades or repairs are needed.

Once we finish collecting data, we use our proprietary models to predict performance at a plant with similar operating characteristics. The Health Check Report Card includes the following:

- The facility’s current standing, including mercury and/or acid gas control equipment;
- ADA’s recommendations for any improvements to your system’s performance or general strategy.

ADA® Health Check will assess the impact of changes in operation, including seasonal changes, cycling load, and fuel variability on future emissions as well as rate MATS control performance using ADA’s proprietary models. ADA considers control of Hg, acid gases, and PM - and the interactions among specific control technologies. The results will include recommendations for on-going compliance, improved reliability, and reduced operating costs.

ADA’S COMPLIANCE HEALTH CHECK: CASE STUDY
ADA performed a Health Check on a 550 MWg pulverized coal-fired boiler, firing subbituminous coal from the Powder River Basin (PRB). The boiler had cold-side ESPs for particulate control and injected brominated powdered activated carbon (PAC) upstream of air preheater (APH) for mercury control. A schematic of the key air pollution control (APC) equipment is shown in Figure 2.
Mercury stack emissions were measured using sorbent traps, which collected mercury for one-week periods. These were aggregated into monthly averages as well as twelve-month rolling averages. Figure 3 shows one year’s worth of averaged Hg emission data. As can be seen in the figure, there was considerable month-to-month variability in average mercury emissions, including some months when the average mercury emission exceeded the emission limit.

Since the compliance mechanism was based on a rolling average, one or two months of high average emissions might not increase the rolling average. However, eventually the rolling average began to approach the limit.

The plant observed that running at reduced load (derating) lowered the Hg emission rate. However, this was not an attractive option. In an attempt to understand the issues, the plant tried a different kind of PAC. In order to do this, they emptied the PAC silo, discarding the old PAC and refilled it with a new PAC. The plant also engaged a stack testing company to make short-term mercury stack measurements during troubleshooting. These actions all cost money, and the plant wasn’t getting closer to finding a solution.
ADA was engaged to carry out a compliance Health Check on the mercury control process at the plant. ADA looked at historical data on operations, fuel composition and Hg emissions and visited the site. During the site visit: ADA inspected the ACI delivery/feed system and requested that the plant take ESP hopper ash samples to obtain an idea of the PAC distribution across the ESP inlet duct.

ADA’s key findings are summarized as follows:

- Inspection of the ACI delivery system and operational parameters did not show plugging of lances or significant flow bias in the distribution manifold;
- Analysis of ESP hopper ash samples showed that there was bias in the distribution of PAC in the flue gas;
- Temperature at APH outlet had a substantial impact on PAC performance (as shown in Figure 4);
- Seasonal average temperature variation (at a given load) was 30-50°F at APH outlet.

ADA used proprietary models for PAC performance to demonstrate that the seasonal variation in APH outlet temperature could explain much of the variation in mercury removal by activated carbon (Figure 5). The distribution of PAC in the duct could be improved to increase the mercury removal and thus reduce carbon consumption. Weekly sorbent traps were the only way the plant knew if they were in compliance, which made them slow to respond to increasing Hg stack emissions. A mercury process monitor could be used to provide real-time feedback about changes in emissions.
SUMMARY

ADA offers plants a review of system operation with the objective of reducing the costs and increasing the reliability of MATS compliance, including:

- Assess current operation
- Unit-specific operations
- Fuel variability and combustion
- APC equipment and performance
- ACI/DSI system operation
- Sorbent usage rate
- CEMs operation/function
- Mercury emissions
- Assess impact of operations, seasonal and cycling operation, and fuel on future emissions
- Rate your Hg control performance using ADA’s proprietary models
- Provide recommendations for on-going compliance to improve reliability and reduce operating costs

ADA® Health Check can help achieve increased mercury and acid gas control system reliability and reduced operating costs.